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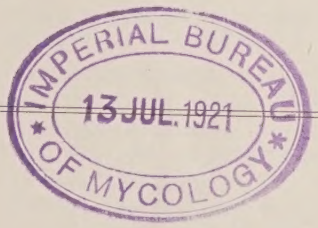

Transmission of Resistance and Susceptibility to Blossom-end Rot in Tomatoes.

By H. P. STUCKEY

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Transmission of Resistance and Susceptibility to Blossom-end Rot in Tomatoes.

By H. P. STUCKEY.

This bulletin is the second in the series planned for the work on blossom-end rot. In the first of the series, bulletin 96 of this Station, it was found that blossom-end rot was not an infectious disease, but due to a physiological trouble and could be controlled by supplying an abundance of moisture to the soil. It was found further that the cherry tomato, (L. cerasiforme), the pear tomato (L. pyriforme) and the currant tomato (L. pimpinellifolium) were immune to the blossom-end rot.

The following is a report on the inheritance of the disease as shown first, in crosses between the cherry type and a commercial variety; and second, in the progeny of plants affected with the blossom-end rot. In the progeny of the crosses, inheritance of size characters, also number of locules or seed cells, has been recorded with the view of determining the possibility of breeding, by this method, a strain of tomatoes of commercial size resistant to the blossom-end rot.

Fig. 1—Red Cherry X Greater Baltimore. Small fruit, Red Cherry; large fruit, Greater Baltimore. Middle Cluster, fruit from first generation plants of the cross. The Red Cherry was used for the male. Size reduced.

Cross Between L. Cerasiforme and L. Esculentum.

In this work, we crossed the Red Cherry (L. cerasiforme) on the Greater Baltimore (L. esculentum). The Red Cherry tomato is, botanically, a two celled or loculed fruit and not more than three locules has been reported. In this species, there are two central placentae arranged on the axis of the fruit, with the characteristic large seed cavity or locule on either side. The fruit is deep red in color, almost globular in shape, and about 7/8 inches in diameter.

The Greater Baltimore is a large fruiting commercial variety, resembling the Stone. The fruit of this variety, representative of the species, L. esculentum, has no central axis. Instead, it has a broken center with its cells or locules arranged in no regular order, some cells enclosing others. The cells or locules are not distinct and can hardly be counted with accuracy. For this reason, this species is listed as "many celled." The fruit of the Greater Baltimore variety has a polar diameter of about 2 inches and an equatorial diameter of about 2 7/8 inches.

From this cross, 17 plants in the first generation progeny resulted. The fruit of these plants was immune to the blossom-end rot, and in size and number of locules was intermediate between the fruit of the two parent varieties, strongly tending towards the Red Cherry type.

Fruits of the first generation plants were produced in the greenhouse, before any other varieties were in bloom, thus preventing any of them being pollinated by pollen from other varieties.

The following table gives the fruit characters of the first generation progeny from the cross:

Plant No.	% B. End Rot	Equatorial diameter inches	Polar diameter inches	No. of Locules
1	0	1 1/4	7/8	3 to 4
2	0	1 1/8	3/4	4
3	0	1 1/4	7/8	3
4	0	1 1/4	1	3 to 5
5	0	1 1/4	1	2 to 3
Fruits of 12 first generation plants fruited in the field:				
1	0	1 3/8	1 1/8	4
2	0	1 1/2	1 1/8	3 to 5
3	0	1 3/4	1 1/8	3 to 5
4	0	1 1/2	1	3 to 5
5	0	1 1/2	1 1/4	3 to 5
6	0	1 1/2	1 1/8	3 to 5
7	0	1 1/2	1 1/4	3 to 5
8	0	1 1/4	1 1/8	3 to 5
9	0	1 3/8	1 1/8	3 to 5
10	0	1 5/8	1 1/4	4
11	0	1 1/2	1 1/4	3 to 5
12	0	1 1/2	1 1/4	3 to 7
Red Cherry	0	5/8	5/8	2
Greater Baltimore	7.21	2 3/4	2	many.

There were no symptoms of blossom-end rot on the fruit of the first generation progeny, even though the plants were subjected to periods of dry weather. From the measurements of the fruit given, it will be seen that the fruit was almost round and took the form largely of the red cherry type. The fruit was perceptibly larger than the fruit of the Red Cherry parent, yet it was very much smaller than the fruit of the Greater Baltimore parent. The number of seed locules in the fruit of the first generation plants varied from two to seven with the exception of three plants which gave fruit with four locules. The fruit of a single plant would vary very greatly in number of locules. It is possible that if the plants that gave four loculed fruit had had a larger number of specimens, that there would have been a variation in number of locules. All the fruit specimens on a plant, where there were less than ten in number, were cut to determine the number of locules.

The fruit of the first generation plants grown in the field was perceptibly larger, on the average, than that of the plants of the same generation grown in the green house. However, the difference in environment was very likely more responsible for the difference in size of fruit than the possibilities of the influences of foreign pollen.

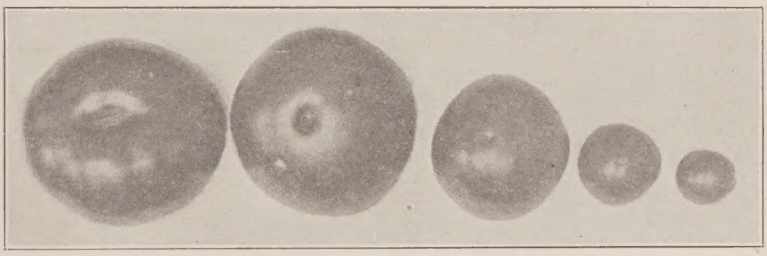

Fig. 2—Fruits from first generation plants of cross between Red Cherry and Greater Baltimore, showing variation in sizes. Two-fifths natural size.

Second Generation.

The plants of the second generation were from the seed of the five plants of the first generation grown in the green house. Twenty plants of the second generation were raised from each one of the five first generation plants, with the exception of No. 4, which gave a poor stand and afforded only eleven plants for the second generation. These plants, twenty to the section, were set to the field in June and encountered long periods of dry weather, which rather dwarfed or held them back until the rains were more plentiful in the latter part of August.

Fruit From Plant 1 of the F_1

Plat No.	% B. End Rot	Equatorial diameter inches	Polar diameter inches	No. of Locules
1	0	1⅜	1 1-16	3 to 4
2	0	⅞	1	3 to 4
3	0	1⅞	1⅜	3 to 4
4	0	1½	1 1-5	3 to 4
5	0	1¾	1⅜	4 to 5
6	0	1¼	1⅛	3 to 4
7	0	1¼	1 1-16	3 to 4
8	0	1¾	1⅜	4 to 5
9	0	2⅝	1⅝	many
10	0	1½	1⅛	5 to 6
11	0	1⅝	1¼	3 to 4
12	0	1¾	1¼	4 to 5
13	0	1⅜	1⅛	3
14	0	1½	⅞	6 to 8
15	0	1 3-16	1	2 to 3
16	0	1¼	1	3 to 4
17	0	1¾	1⅛	3 to 4
18	0	1½	1⅛	4 to 5
19	0	1⅛	⅞	3 to 4
20	0	1¼	1⅛	2 to 3

Fruit From Plant 2 of the F_1

Plat No.	% B. End Rot	Equatorial diameter inches	Polar diameter inches	No. of Locules
1	0	1¼	1⅛	5 to 6
2	0	2⅛	1⅜	4 to 5
3	0	1⅝	1¼	3 to 5
4	0	1¼	1⅛	2 to 3
5	0	1½	1 3-16	2 to 3
6	0	1⅛	1	2 to 4
7	0	1⅝	1 1-5	5 to 6
8	0	1⅜	1¼	2 to 3
9	0	1 9-16	1¼	3 to 4
10	0	1⅜	1¼	3 to 4
11	0	1⅝	1¼	4 to 5
12	0	1½	⅞	4 to 5
13	0	1⅝	1 5-16	2 to 3
14	0	1⅞	1½	4 to 5
15	0	1¾	1¼	6 to many
16	0	1¼	1⅛	2 to 3
17	0	1¼	1⅛	2 to 3
18	0	1½	1⅛	3 to 4
19	0	1	⅞	2 to 3
20	0	1¼	1 1-16	4 to 5

Fruit From Plant 3 of the F_1

Plat No.	% B. End Rot	Equatorial diameter inches	Polar diameter inches	No. of Locules
1	0	1¼	1	4 to 4
2	0	1 3-16	1	2 to 5
3	0	1⅜	1	4
4	0	1½	1¼	3 to 5
5	0	1⅜	1⅛	3 to many
6	0	1⅛	1	3 to 4

7	0	1 5-16	1	3 to 4
8	0	1¼	1	2 to 3
9	0	1⅛	1 1-16	2 to 3
10	0	1⅜	1¼	2 to 3
11	0	2	1¼	3 to 5
12	0	1¾	1⅜	3 to 4
13	0	1⅜	1⅛	3 to 4
14	0	1⅛	1	2 to 3
15	0	1½	1⅛	3 to 4
16	0	1⅛	1	2 to 4
17	0	1⅛	1	2 to 3
18	0	1⅝	1¼	3 to 4
19	0	1	⅞	2 to 3
20	0	1⅞	1¼	4 to 5

Fruit From Plant 4 of the F_1

Plat No.	% B. End Rot	Equatorial diameter inches	Polar diameter inches	No. of Locules
1	0	1½	1	4 to 5
2	0	1½	1¼	2 to 4
3	0	1¾	1¼	Many
4	0	2⅜	1½	Many
5	0	1¼	1	2 to 4
6	0	1¼	1⅛	2 to 3
7	0	1¼	1	3 to 4
8	0	1⅜	1⅛	2 to 4
9	0	1¼	1	2 to 3
10	0	1½	1⅜	3 to 4
11	0	1⅛	⅞	3 to 4

Fruit From Plant 5 of the F_1

Plat No.	% B. End Rot	Equatorial diameter inches	Polar diameter inches	No. of Locules
1	0	1	⅞	2 to 3
2	0	1½	1¼	3 to 4
3	0	1⅜	1⅜	2 to 3
4	0	1¼	1	3 to 4
5	0	1¼	1 1-16	3 to 4
6	0	1⅛	1	2 to 3
7	0	1½	1 3-16	4 to 5
8	0	1⅜	1⅛	4 to 6
9	0	1⅛	1	2 to 3
10	0	1⅛	1	3 to 4
11	0	1	1	2 to 3
12	0	1½	1¼	3 to 4
13	0	1¼	1⅛	2 to 3
14	0	1	⅞	2 to 3
15	0	1	1	2 to 3
16	0	⅞	1	2
17	0	1⅜	1⅛	3 to 4
18	0	1½	1⅛	3 to 4
19	0	1½	1⅛	3 to 4
20	0	1½	1 3-16	6 to many

The second generation plants were subjected to a considerable period of dry weather, a condition so conducive to blossom-end rot of the fruit, but no symptoms of the disease were observed. In studying the progeny through two generations from the cross

and finding no symptoms of the blossom-end rot on the fruit of any of the plants of either generation, we are led to believe that the resistance or immunity to the blossom-end rot of the Cherry tomato used in the original cross is an inheritable character and remains dominant through at least two generations of the progeny.

The fruit of the second generation progeny is more variable in size and in number of locules than that of the first generation progeny, and a few of the fruit specimens tended in size and structure towards the commercial type represented by the Greater Baltimore variety used in the original cross.

There seems to be no distinct Mendelian segregation of fruit characters in the second generation of plants. The size of the fruit ranges from that of the Red Cherry to about three-fourths the size of the Greater Baltimore, with a larger majority of intermediates tending toward the size of the Red Cherry. Of the 71 second generation plants only six produced fruit with the broken center and "many" locules or seed cells, typical of the Greater Baltimore and other commercial varieties of the esculentum species.

Yield of Varieties and Their Susceptibility to the Blossom-end Rot.

A number of the standard varieties of tomatoes were grown to compare their yield and susceptibility to the blossom-end rot with varieties said to be immune, and with a strain of the Globe variety from seeds grown the previous season on a plant badly infected with blossom-end rot.

The seeds for the first Globe variety mentioned in the table were purchased from a commercial seedsman. Those for the second Globe variety were grown the previous season on a plant, the fruit of which was badly attacked by the blossom-end rot.

The following table gives the result:

Fig. 3—Tomato plant from blossom-end rot parentage. Fifteen fruits on the plant; thirteen of them had blossom-end rot.

Variety	No. of plants grown	Lbs. harvested before June 30		Per cent of Blossom End Rot by Count June 30	Lbs. Marketable after June 30.	Total Pounds Marketable	No. Plants Wilted or Dead from Fusarum Wilt June 30
		Marketable	Unmarketable				
Acme	12	10.05	1.25	2.25	22.80	32.95	3
Texas Bell	12	12.05	.35	0	16.15	28.20	4
Redfield Beauty...	12	9.20	2.20	6.18	21.60	30.80	4
Greater Baltimore	12	7.50	3.15	7.21	18.70	26.20	4
John Baer	12	6.45	2.45	6.66	13.00	19.45	8
Sparks Earliana ..	12	15.25	1.80	1.66	15.65	30.90	1
Alacrity 14 A	12	12.65	1.30	0	14.40	27.05	2
Alacrity 12 A	12	13.00	1.25	0	29.35	42.35	1
My Maryland	12	7.40	4.30	2.98	16.80	24.20	6
Prosperity	12	9.35	3.45	2.20	19.70	29.05	3
Globe	12	5.85	1.75	15.45	20.10	25.95	1
Prolific IXL	12	12.65	2.45	2.60	13.20	25.85	2
Hybrid (a)	12	22.65	.35	0	21.95	44.60	0
Red Cherry	4	.....	....	0	.....	.....	0
Globe (b)	12	11.40	4.10	80.00	6.65	18.05	0

(a) First generation plants from crosses of Red Cherry and Greater Baltimore.
(b) Plants from seeds of plants with 75% blossom-end rot previous season.

The latter part of June was quite dry giving conditions favorable to the development of the blossom-end rot. The very early maturing varieties, such as Alacrity and Sparks Earliana were attacked very little by the blossom-end rot for the reason that they had matured the most of their fruit beyond susceptibility to the blossom-end rot before the weather became extremely dry. The Texas Bell, Hybrid, and Red Cherry are of the cerasiforme type and were expected to be immune.

The most interesting point to note in the table is the higher percentage of blossom-end rot shown in the fruit of the plant whose parents had seventy-five percentage of the blossom-end rot. This percentage of blossom-end rot is high above anything else in the table, showing the extreme susceptibility of the plants to the disease. This, together with the resistance to the disease shown in the hybrids of two generations from the Cherry type would lead us to infer that certain physiological structures that make for or against susceptibility to the disease are transmitted to the progeny. These plants as compared with the others were either unable to extract from the soil enough moisture to support the young fruits, or else, utilized the moisture for other parts of the plant at the expense of the fruit.

The Fusarium wilt and leaf spot attacked the plants of practically all the varieties late in June which cut off a larger percentage of the yield of the late maturing varieties than of the early maturing ones. Had it not been for the attacks of these diseases, the yield certainly would have been larger and doubtless would have been in a different ratio.

One interesting point in connection with the yields is that the Hybrid, the plants of which are the first generation progeny of

the cross between the Red Cherry and the Greater Baltimore gave the highest yield of all the varieties. This is in accord with results obtained at the Geneva Experiment Station[1] from first generation hybrid tomato plants of commercial varieties.

SUMMARY.

1. Resistance to the blossom-end rot seems to be transmitted from parent to progeny.

2. Susceptibility to the blossom-end rot seems to be transmitted from parent to progeny.

3. The fruit of the first generation progeny from a cross between L. cerasiforme and L. esculentum is resistant to the blossom-end rot and is intermediate in size and number of locules between the two parents, but tends towards that of L. cerasiforme.

4. The fruit of the second generation progeny of the cross between L. cerasiforme and L. esculentum is resistant to the blossom-end rot and varies widely in size of fruit and number of locules. However, no distinct mendelian segregation of these two characters was observed.

[1] Bulletin 346, Geneva Experiment Station.